

## STUDIES ON THE NEARCTIC *EUCHLOE*

### PART 1. INTRODUCTION

PAUL A. OPLER

*Department of Entomology  
University of California, Berkeley, California*

THIS PAPER WILL SERVE as the introduction for a series of papers which will present the results of an investigation primarily concerned with systematic placement of Nearctic members of the genus *Euchloe* Hübner. The genus *Euchloe* is composed of butterflies known as "marbles" which are members of the family Pieridae. The larvae of these insects feed upon species of Cruciferae. Populations of one or more species are found throughout most of the Nearctic Zoogeographic Region but occur most frequently in somewhat xeric habitats in the western United States and Canada. The taxonomic relationships of the Palaearctic and Ethiopian members of the genus are not considered in this study. Brief references will be made to the Old World entities in order to clarify important points relating to Nearctic members of the genus.

The author hopes to correct several faulty systematic concepts which have been applied to the Nearctic members of *Euchloe* for many years. These misunderstandings were due to the fact that the adults were identified by a few superficial external characteristics.

To correct the above stated situation, an attempt has been made to arrive at a more meaningful systematic treatment of the genus which will reflect probable phylogenetic relationships. This study presents the results of an analysis based on morphological, distributional, and ecological characteristics of all Nearctic members of the genus. Based on this analysis a workable systematic framework is presented.

Four species of Nearctic *Euchloe* are recognized: *E. ausonides* (Lucas), *E. creusa* (Doubleday), *E. olympia* (Edwards), and *E. hyantis* (Edwards). These are believed to be phylogenetically and morphologically divisible into two species groups. One is comprised of *E. ausonides*, *E. creusa* and *E. olympia*, and will be referred to as the *E. ausonides* group. The other is composed of *E. hyantis* and its several segregates; this group will be referred to as the *E. hyantis* complex.

<sup>1</sup>The bulk of the material presented in this series of papers was part of a thesis presented in partial fulfillment of the requirements for the degree of Master of Arts at San Jose State College, San Jose, California. Dr. J. W. Tilden of the above institution was research advisor.

Two new combinations will be presented as subspecific designations of *E. hyantis* in a later paper.

Below are the titles of the papers which are anticipated for this series.

Part 1: INTRODUCTION

Part 2: CHRONOLOGICAL LITERATURE REVIEW  
AND BIBLIOGRAPHY

Part 3: COMPLETE SYNONYMICAL TREATMENT

Part 4: TYPE INFORMATION

Part 5 DISTRIBUTION

Part 6: ADULT MORPHOLOGY AND KEY TO IDENTIFICATION

Part 7: LARVAL MORPHOLOGY AND KEY TO IDENTIFICATION

Part 8: BIONOMICS

Part 9: DISCUSSION AND SUMMARY

#### ACKNOWLEDGMENTS

The author expresses his gratitude to J. W. Tilden of San Jose State College who gave direction to this study. F. M. Brown, H. K. Clench, C. F. dos Passos, Paddy McHenry, J. A. Powell, and N. D. Riley contributed advice and information which made the construction of the synonymies and the writing of the portions which dealt with the type material an easy task. P. R. Ehrlich, T. H. Emmel, C. L. Remington, O. E. Sette, and Fred Thorne contributed invaluable information on the biology and the morphology of the genus. A. B. Klots, C. D. MacNeill, L. M. Martin, as well as Tilden gave freely of their knowledge on biological concepts with special regard to members of the genus *Euchloe*. I am also grateful for the advice on special techniques, equipment, and methods which was given by R. C. Ballard, J. G. Edwards, W. E. Ferguson, C. D. MacNeill, J. A. Powell, C. L. Remington, and J. W. Tilden. I greatly appreciated the suggestions of Leroy Parks, E. S. Ross, and Ronald Stecker about details concerning the format of these papers. My sincere thanks to Peter Herlan, Nevada State Museum, MacNeill, California Academy of Sciences, Martin, Los Angeles County Museum, Powell, California Insect Survey, University of California, Berkeley, and F. H. Rindge, American Museum of Natural History who allowed me to examine or borrow the specimens of *Euchloe* in collections under their care. The following individuals kindly loaned specimens from their personal collections: Richard Brown, Concord, California, John Lane, Los Angeles, California, R. L. Langston, Kensington, California, R. E. Stanford, Los Angeles, California, and Fred Thorne, El Cajon, California. E. J. Newcomer of Yakima, Washington collected many specimens of *Euchloe* from that state for the author's examination. C. W. Sharsmith of San Jose State College kindly confirmed or corrected the author's determination of plant specimens. Margaret S. Bergseng of the University of California Herbarium determined two species of Cruciferae which were collected during the summer of 1965. My special thanks are extended to J. W. Tilden, H. T. Harvey, and C. W. Sharsmith, who read the thesis upon which these papers are based and helped to correct errors. Any errors which occur in these papers are the responsibility of the writer.

## PART 2. CHRONOLOGICAL REVIEW OF THE LITERATURE AND BIBLIOGRAPHY

THE FIRST PORTION OF THIS PAPER will deal with the development of the concepts concerning the specific status of the *Euchloe* of the Nearctic Region. The second portion is a complete bibliographic listing of all of the literature which is cited in the papers of this series.

### CHRONOLOGICAL REVIEW OF THE LITERATURE

In this review opinions of all authors which contain contributions to development of concepts concerning the status of Nearctic *Euchloe* are given. Personal interpretations are made by this writer for the sake of bringing clarity to past opinions which, in the view of the author, are often illogical or nebulous due to the presentation of insufficient information.

As an aid in evaluation of this study a brief synonymy of the names that have been proposed for Nearctic *Euchloe* is presented:

#### *Euchloe* (*Euchloe*)

1. *ausonides* (Lucas), 1852  
     Var. *flavidalis* Comstock, 1924  
     Var. *semiflava* Comstock, 1924  
     ab. *boharti* Doudoroff, 1930  
     (*coloradensis*) ab. *hemiflava* Field, 1936  
     *A. ausonides coloradensis* (Hy. Edw.), 1881  
     (*belia belioides*) race *montana* Verity, 1908  
     *B. ausonides mayi* Chermock & Chermock, 1940
2. *olympia* (Edwards), 1871  
     *A. olympia rosa* (Edwards), 1871
3. *creusa* Doubleday, 1847  
     Var. *elsa* Beutenmüller, 1898  
     (*belia*) var. *orientalides* Verity (Partim.), 1908
4. *hyantis* (Edwards), 1871  
     (*belia*) var. *pseudoausonides* Verity, 1908  
     *A. hyantis lotta* Beutenmüller, 1908 New Combination  
     (*creusa*) ab. *pumilio* Strand, 1914  
     (*belia*) var. *orientalides* Verity (partim.), 1908  
     *B. hyantis andrewsi* Martin, 1936 New Combination

Doubleday & Hewitson (1847) named *Euchloe creusa* as the first entity of the genus for North America based on specimens collected in the Rocky Mountains of Canada by Lord Derby. [Westwood died before date of publication] No description was given, and the identity of the form was based only on a type specimen [not designated] and an inadequate plate figure.

Lucas (1852) described *Euchloe ausonides* on the basis of specimens collected in California by Lorquin. No figure was included, but lengthy descriptions of both sexes were given.

Boisduval (1852) mentioned the name *ausonides* in a paper on the butterflies of California. Boisduval was credited as the



author of the name in many citations due to a misunderstanding of publication dates. Dos Passos (1962) gave detailed information concerning the dates of publication of the papers in question on the basis of which Lucas is credited with the authorship of *ausonides*.

Edwards (1863) redescribed *ausonides* from California, Canada, and Colorado. It is interesting that this description could be applied to any of the Nearctic entities with the possible exception of *Euchloe olympia*.

Edwards (1871) described *Euchloe hyantis* from specimens collected at Mendocino City, Mendocino County, California by R. H. Stretch.

Strecker (1878) treated *ausonides* as a variety of *Euchloe ausonia*, a Palaearctic form.

Henry Edwards (1881) described *Euchloe ausonides coloradensis*. This name was proposed as a new species according to the taxonomic usage which was in practice at that time. The description included was just sufficiently detailed to establish the identity of the insect. The type was collected by T. L. Mead in June, 1871 while he was in Colorado with the Wheeler Geographical Expedition.

Beutenmüller (1898) wrote the only revision of the Nearctic *Euchloe* prior to the present study. In this revision the author revised his opinions from those expressed in his paper of 1897. He introduced two new names, *Euchloe lotta* described as a specific entity, and *Euchloe creusa elsa*, which has been subsequently treated as a synonym of *creusa*. The name *lotta* was proposed for the entity found in the Artemisian Biome and deserts of the southwestern United States. Previously, the name *creusa* had been applied to these populations, which Beutenmüller correctly realized were not conspecific with *creusa*. Although Beutenmüller's concept had an insight into relationships involved, he not only did not explain the reasons for his arrangement of the entities within the genus, but incorrectly considered the name *hyantis* to be a synonym of *creusa*.

Butler (1899b) published a paper in response to the work of Beutenmüller (1898) in which Butler stated that all Nearctic entities were forms of *ausonides*.

Beutenmüller (1899) stated, in a reply to the comments of Butler (1899b), "I concluded that it would be best to allow the species to remain distinct until more light could be obtained on the subject." He then proceeded to elaborate on his concept pertaining to the identities of *creusa* and *hyantis lotta*.

Browning (1901), in a faunal paper on the Rhopalocera of the Salt Lake City, Utah, region, figured a specimen of *hyantis lotta*. He correctly applied the name *lotta* to the specimen, but incorrectly assumed it to be a variety of *ausonides*, which can be seen immediately by referring to the above mentioned plate.

Franck (1905) stated that he believed the name *hyantis* to represent a subspecific entity of *ausonides* and that the name *coloradensis* was a synonym of *hyantis*. No basis was given for this idea.

The probable identity of *Euchloe* illustrated by Wright (1906) indicates that in only one or two cases is it possible that the collection data are correct.

Coolidge (1908) attempted to present an arrangement of Nearctic entities which would eliminate the wide range of differing treatments of the genus. He placed *lotta* and *hyantis* as subspecific names under *creusa* and placed *coloradensis* as a synonym of *ausonides*. This arrangement, in an only slightly modified form, was restated by Barnes and McDunnough (1916), and gradually assumed the position as the "correct" treatment of the Nearctic members of the genus. This concept was given no biological or morphological basis.

Verity (1908) attempted to enforce upon the new world members of the genus *Euchloe* a biological phenomenon which was well documented in the Palearctic Region, i.e., the occurrence of two morphologically distinct seasonal forms for each entity. Several unnecessary new names and some very unwieldy nomenclatorial combinations resulted. The types of *ausonides* and *creusa* were figured in this work.

Strand (1914) described an aberration *hyantis lotta* from Oregon by the name *pumilio*. He incorrectly used the name in combination with *creusa*.

Barnes and McDunnough (1916) gave a lengthy discussion of their opinions of the relationships of North American members of *Euchloe*. Although the authors reinforced the erroneous arrangement initiated by Coolidge (1908), they corrected the mistake by Verity concerning the presence of seasonal forms in the Nearctic Region by placing all of Verity's names in synonymy. They also correctly considered the name *elsa* to be a synonym of *creusa*, and raised *coloradensis* from synonymy as a subspecies of *ausonides*.

Barnes and McDunnough (1917) presented the arrangement of the Nearctic entities of the genus *Euchloe* which was to be followed for many years. The following citations repeated the

treatment of Barnes and McDunnough; Barnes and Benjamin (1926), Comstock (1927), and dos Passos (1964).

Comstock (1924) described two varietal color forms of female *ausonides*, which were collected from the populations which occur in the vicinity of San Francisco Bay, California. Comstock evidently did not know that one of these color forms, *semiflava*, is normal for the females of this species, since the hindwing of the female in other species does not show a contrast in pigmentation with the forewing. The variation in pigmentation of this group will be presented in greater detail in a later paper of this series.

Coolidge (1925) described the life history of *Euchloe hyantis lotta* on the basis of material collected in the western Mojave Desert of California. Coolidge repeated his mistake of an earlier paper (Coolidge, 1908) by associating the name *hyantis* with *Euchloe creusa*.

Comstock (1927) in "Butterflies of California" introduced two somewhat erroneous concepts which were perpetuated because of the popularity which this book attained. Although Comstock figured specimens of *ausonides coloradensis* from Colorado, he stated in the text that this subspecies "is occasionally taken in the high mountains of California". This statement led to the practice of referring to all specimens of *Euchloe* collected in the Sierra Nevada as "*Euchloe ausonides coloradensis*". Some small isolated populations of *ausonides* are to be found in the Sierra Nevada; however, most population of *Euchloe* in that range are *hyantis*. The latter situation and the fact that Comstock's treatment of *hyantis* was somewhat nebulous led to misunderstandings of *hyantis*.

Doudoroff (1930) gave to a melanic specimen of *Euchloe ausonides* the name *boharti*.

Klots (1930b) reported *E. creusa* from Teton County, Wyoming. Specimens from this collection have been examined by the author and proved to represent *hyantis lotta*.

Holland (1931) figured the type of *hyantis* and a specimen which may represent the type of *Euchloe hyantis lotta*. Holland treated the names *ausonides* and *coloradensis* conspecifically, and considered the names *creusa*, *lotta*, and *hyantis* to represent separate species. His statement of the distribution of the latter entities showed that he had no clear concept of their relationships.

Field (1936) described a male color form of *Euchloe ausonides* from Utah in which the "upper surface of the secondaries [was] suffused over with yellow". Not only did Field incorrectly attribute this specimen to the name *coloradensis*, but he may have been incorrect in assuming that it was a male.

Martin (1936) described a population of *Euchloe* from the San Bernardino Mountains of southern California. He gave to this race the name *andrewsi* in honor of the collector, R. H. Andrews. This population should be referred to as a subspecific category of *Euchloe hyantis* rather than of *Euchloe ausonides* as it has been treated.

Chermock and Chermock (1940) described *Euchloe ausonides mayi*, a distinctive population from the Riding Mountains of Manitoba.

Brooks (1942) erroneously considered *ausonides coloradensis* to occur in Manitoba.

Leighton (1946) reported *creusa* and "*Euchloe creusa hyantis*" as occurring in eastern Washington. The insects referred to by these two names were probably specimens of *Euchloe hyantis lotta*. Newcomer (1964) followed this procedure in reporting *creusa* from Yakima County, Washington.

Bauer (1953) applied the name *creusa* to *hyantis lotta* from Arizona.

Brown (1955) used the name *creusa* to represent specimens of *hyantis lotta* from western Colorado. Brown showed that he was aware of difference between *hyantis lotta* and *ausonides coloradensis* by his list of differentiating characteristics in the appearances of the two entities.

Powell (1958) and others have used the combination *ausonides andrewsi* to refer to specimens of *Euchloe* from the peninsular ranges of Baja California Norte. Populations of *Euchloe* from the peninsular ranges of southern California, and Baja California Norte, referable to *hyantis*, do not represent the names *andrewsi* or *lotta*.

Ehrlich and Ehrlich (1961) used the names *Euchloe ausonides*, *Euchloe olympia*, and *Euchloe creusa* to represent all of the entities of *Euchloe* found in the Nearctic Region. The authors state that *Euchloe creusa* "is only doubtfully distinct from *Euchloe ausonides*."

Garth and Tilden (1963) followed the usage of Comstock (1927) in reporting "*Euchloe creusa hyantis*" and *Euchloe ausonides coloradensis* from the central Sierra Nevada of California.



Storer and Usinger (1963) used the name "*Euchloe coloradensis*" in referring to a *Euchloe* found in the Sierra Nevada of California.

Dos Passos (1964) adds the dates of the original citations for all of the names involved, his arrangement is little changed from that of Barnes and McDunnough (1917)

### LITERATURE CITED

- ANDERSON, E. E. 1904. *Catalogue of British Columbia Lepidoptera*. Provincial Museum, Victoria, B.C., 56 pp.
- ARNHOLD, F. R. 1952. Notes on collecting *Anthocharis midea* and *Euchloe olympia*. *Lep. News* 6(6-8): 99-100.
- AXELROD, D. I. 1959. in: Munz and Keck, *A California Flora*. University of California Press, Berkeley & Los Angeles, pp. 5-9.
- BARNES, W. & F. H. BENJAMIN. 1926. Checklist of the diurnal Lepidoptera of boreal America. *Bull. So. Calif. Acad. Sci.* 25(1): 3-27.
- BARNES, W. & J. H. McDUNNOUGH. 1916. *Contr. Nat. Hist. Lepid. North America* 3(2): 59-62.
- . 1917. *Checklist of the Lepidoptera of boreal America*. Decatur, Illinois. 392 pp.
- BAUER, D. L. 1953. Butterflies at water holes in central Arizona. *Lep. News* 7(5-6): 146-147.
- BEUTENMÜLLER, W. 1897. Minutes of October, 1897 meeting of the New York Entomological Society. *J. New York Ent. Soc.* 5: 208.
- . 1898. Revision of the species of *Euchloe* inhabiting America north of Mexico. *Bull. Amer. Mus. Nat. Hist.* 10(13): 235-248.
- . 1899. Notes on the American forms of *Euchloe*, Hubner. *Can. Ent.* 31(3): 56.
- BIRD, C. D. 1956. Collection of Rhopalocera from the Whiteshell Forest Reserve, Manitoba. *Lep. News* 10: 107-108.
- BISERTE, F. 1960. *Chromatographie en chimie organique et biologique* (E. Lederer, ed.), vol. 2. Masson & Sons, Paris. 876 pp.
- BOISDUVAL, J. A. 1852. *Lepidopteres de la Californie*. *Ann. Soc. Ent. France* 2: X, 275-324.
- . 1869. *Lepidopteres de la Californie*. *Ann. Soc. Ent. Belgique* 12: 11-94.
- BROOKS, G. S. 1942. A revised checklist of the butterflies of Manitoba. *Can. Ent.* 74(2): 31-33.
- BROWN, F. M. 1955. The Butterflies of Colorado, part IV, Pieridae, Papilionidae. *Proc. Denver Mus. Nat. Hist.* 6: 177-236.
- BROWNING, G. W. 1901. Collecting in the vicinity of Salt Lake City. *Ent. News* 12: 297-304.
- BUTLER, A. G. 1882. On the butterflies collected by Lord Walsingham in California. *J. Linnaean Soc.* 16: 462-474.
- . 1899a. Notes on the genus *Euchloe*, Hubner, a genus of Pierinae. *Entomologist* 32: 1-3.
- . 1899b. Notes on the American forms of *Euchloe* Hubn. *Can. Ent.* 31: 19.
- CHANG, V. C. S. 1963. Quantitative analysis of certain wing and genitalia characters of *Pieris* in western North America. *Jour. Res. Lepid.* 2(2): 97-125.
- CHERMOCK, F. H. & R. L. 1940. Some new diurnal Lepidoptera from the Riding Mountains and the Sand Ridge, Manitoba. *Can. Ent.* 72(4): 81-83.
- COCKRELL, T. D. A. 1899. On the origin of the genus *Anthocharis*, Bdv. (= *Euchloe*, Hb.). *Ent. Amer.* 5: 33-34.



- COMSTOCK, J. A. 1924. New races of California butterflies. *Bull. So. California Acad. Sci.* 23(2): 51-52.
- . 1927. *The butterflies of California*. Comstock, Los Angeles. 334 pp.
- COMSTOCK, J. A. & C. M. DAMMERS. 1932. Metamorphoses of five California diurnals (Lepidoptera). *Bull. So. California Acad. Sci.* 31(2): 33-45.
- COOLIDGE, K. R. 1908. Notes on *Euchloe hyantis*, Edw. *Can. Ent.* 40: 298-300.
- . 1925. The life history of *Euchloe creusa hyantis* Edw. *Ent. News* 36: 65-68.
- COOLIDGE, K. R. & E. J. NEWCOMER. 1908. The life history of *Euchloe ausonides*. *Ent. News* 19: 204-210.
- CROSS, F. C. 1937. Butterflies of Colorado. *Proc. Colorado Mus. Nat. Hist.* 16(1): 3-28.
- DAVENPORT, D. & V. G. DETHIER. 1937. Bibliography of the described life histories of the Rhopalocera of America north of Mexico 1889-1937. *Ent. Amer.* 17(4): 155-194.
- DICE, L. R. 1943. *The biotic provinces of North America*. Univ. Michigan Press, Ann Arbor. 78 pp.
- DOS PASSOS, C. F. 1962. The authorship of three scientific names of Nearctic Rhopalocera variously credited to Boisduval or Lucas. *J. Lep. Soc.* 16(1): 45-46.
- . 1964. A synonymic list of Nearctic Rhopalocera. *Lep. Soc. Mem.* 1: 1-145.
- DOUBLEDAY, E. & J. W. WESTWOOD. 1847. *The genera of diurnal Lepidoptera*. Illustrated W. G. HEWITSON [Westwood died before the publication date]. Longman, Brown, Green and Longmans, London. 1: 250 pp.
- DEFOLIART, G. R. 1956. Annotated list of southeastern Wyoming Rhopalocera. *Lep. News* 10(3-4): 91-101.
- DOUDOROFF, M. 1930. A new aberration of *Euchloe ausonides*. *Pan-Pac. Ent.* 6(3): 143.
- DYAR, H. G. 1894. Notes on *Pieris* and *Anthocharis*. *Can. Ent.* 26: 110.
- . 1902. A list of North American Lepidoptera and key to the literature of this group of insects. *Bull. U. S. Nat. Mus.* 52: 1-723.
- EDWARDS HENRY. 1880. Pacific Coast Lepidoptera. No. 22: 11 pp., No. 28: 2 pp. Henry Edwards, New York.
- . 1881. On some apparently new forms of diurnal Lepidoptera. *Papilio* 1(4): 50-55.
- EDWARDS, W. H. 1863. Descriptions of certain species of diurnal Lepidoptera found within the limits of the United States and British America. *Proc. Ent. Soc. Philadelphia* 2: 78-82.
- . 1871. Descriptions of new species of diurnal Lepidoptera found within the United States. *Trans. Amer. Ent. Soc.* 3: 205-216.
- . 1884. Revised catalogue of the diurnal Lepidoptera of America north of Mexico. *Trans. Amer. Ent. Soc.* 9: 245-337.
- . 1892. Miscellaneous notes on butterflies, larvae, etc. *Can. Ent.* 24(3, 5): 52, 109.
- . 1897. *Butterflies of North America*. Houghton-Mifflin, Boston. 2: 342 pp., 3: 432 pp.
- EHRlich, P. R. 1961. Comparative morphology of the male reproductive system of the butterflies (Lepidoptera: Papilionoidea). 1. some

- Nearctic species. *Microent.* 24(4): 135-136.
- EHRlich, P. R. & A. H. 1961. *How to know the butterflies*. Wm. C. Brown Co., Dubuque, Iowa. 262 pp.
- . 1962. The head musculature of the butterflies (Lepidoptera Papilionoidea). *Microent.* 25(1): 1-89.
- ELROD, J. E. & F. I. MALEY. 1906. The butterflies of Montana. *Bull. Univ. Montana* 30(biol. ser.): 174 pp.
- FIELD, W. D. 1936. New North American Rhopalocera. *J. Ent. & Zool.* 28(2): 18-26.
- FRANCK, G. 1905. Notes of *Anthocharis* at meeting of Brooklyn Entomological Society. *Ent. News* 16: 28-29.
- GARTH, J. S. 1934. Butterflies of the Boundary Hill Research Reserve, Yosemite National Park, Calif. *Bull. So. California Acad. Sci.* 33(3): 131-135.
- . 1935. Butterflies of Yosemite National Park. *Bull. So. California Acad. Sci.* 34(1): 37-75.
- GARTH, J. S. & J. W. TILDEN. 1963. Yosemite butterflies. *Jour. Res. Lepid.* 2(1): 1-96.
- GEDDES, G. 1883. List of diurnal Lepidoptera collected in the Northwest Territory and the Rocky Mountains. *Can. Ent.* 15(12): 221-223.
- GOOD, P. M. & A. W. JOHNSON. 1949. Paper Chromatography of Pterins. *Nature* 163(4131): 31.
- GROTE, 1900. The descent of the Pierids. *Proc. Amer. Phil. Soc.* 39: 4-67.
- GUNDER, J. D. 1930. Butterflies of Los Angeles County, California. *Bull. So. California Acad. Sci.* 29(2): 39-35.
- HADORN, E. & H. K. MITCHELL. 1951. Properties of mutants of *Drosophila melanogaster* and changes during development as revealed by paper chromatography. *Proc. Nat. Acad. Sci.* 37: 650-665.
- HERRICH-SCHAFFER. 1867. *Prodromus systematis Lepidopterorum*. *Corr.-Blatt. Zool. Min. Ver. Regnsb.* 21: 138-144.
- HOLLAND, W. J. 1898. *The butterfly book*. Doubleday, Page, & Co., Garden City, New York. 382 pp.
- . 1931. *The butterfly book*, rev. ed. Doubleday & Co., Garden City, New York. 424 pp.
- HOVANITZ, W. & V. C. S. CHANG. 1962. Three factors affecting larval choice of food plant. *Jour. Res. Lepid.* 1(1): 51-61.
- KIRBY, W. F. 1871. *A synonymic catalogue of diurnal Lepidoptera*. John Van Voorst, London. 690 pp.
- KLOTS, A. B. 1930a. A generic revision of the Euchloini (Lepidoptera, Pierinae). *Bull. Brooklyn Ent. Soc.* 25: 80-95.
- . 1930b. Diurnal Lepidoptera from Wyoming and Colorado. *Bull. Brooklyn Ent. Soc.* 25: 147-170.
- . 1956. in: Tuxen, *Taxonomist's glossary of genitalia in insects, Lepidoptera*. Ejnar, Copenhagen. pp. 97-111.
- LEIGHTON, B. V. 1946. The butterflies of Washington. *Univ. Washington Pub. Biol.* 9(2): 47-63.
- LUCAS, P. H. 1852. Description de nouvelles especes de Lepidopteres. *Revue et magazine de zoologie* 4 (2nd ser.): 324-245.
- MAEKI, K. & C. L. REMINGTON. 1960. Studies of the chromosomes of North American Rhopalocera, 2. HesperIIDae, Megathymidae, and Pieridae. *J. Lep. Soc.* 14(1): 37-57.
- MARTIN, L. M. 1936. A new southern race of *Euchloe ausonides* (Diurnal Lepidoptera). *Bull. So. California Acad. Sci.* 35(2): 94-95.

- MARTIN, L. M. & C. H. INGHAM. 1931. An annotated list of diurnal Lepidoptera of Huntington Lake region, Fresno County, California. *Bull. So. California Acad. Sci.* 29(3): 115-134.
- MARTIN, L. M. & F. S. TRUXAL. 1955. A list of North American Lepidoptera in the Los Angeles County Museum. *Los Angeles Co. Mus. Sci. Ser.* No. 18, Zool., No. 8: 35 pp.
- McDUNNOUGH, J. H. 1938. Check list of the Lepidoptera of Canada and the United States of America, part 1, Macrolepidoptera. *Memoirs So. California Acad. Sci.* 1(1): 272 pp.
- MEAD, T. L. 1875. in: Wheeler, *United State geographical surveys west of 100th meridian*. 5(zoology): 1021 pp. Washington, D.C., U. S. govt. printing office.
- . 1877. Notes on certain California diurnals. *Psyche* 2: 179-184.
- MEINERS, E. P. 1956. Lepidoptera collecting at Ranken, Missouri. *Lep. News* 10(5): 163-168.
- MERRITT, J. R. 1952. Butterflies and hilltops. *Lep. News* 6(6-8): 101-102.
- MILLER, A. H. 1951. An analysis of the distribution of the birds of California. *Univ. California Pub. Zoology* 50: 531-644.
- MORRISON, H. K. 1883. List of species of butterflies collected in Arizona by Mr. H. K. Morrison, in 1882. *Papilio* 3(1): 9-10.
- MÖSCHLER, B. 1878. Catalogue of the Lepidoptera north of Mexico. *Stett. Ent. Zeit.* 39: 299, 309.
- MUNZ, P. A. & D. D. KECK. 1959. *A California flora*. University of California Press, Berkeley & Los Angeles. 1681 pp.
- NEWCOMER, E. J. 1964. Butterflies of Yakima County, Washington. *J. Lep. Soc.* 18(4): 227-228.
- OBERTHUR, C. 1920. *Etudes de Lepidopterologie comparee*, vol. 17.
- OSTEN-SACKEN, R. VON. 1882. List of butterflies collected on the Pacific coast, principally in California in 1876, with notes on their localities and habits. *Papilio* 2(2): 29-31.
- PEILE, H. D. 1922. The butterflies of Mesopotamia, part II. *J. Bombay Nat. Hist. Soc.* 28: 245-369.
- PETERSON, A. 1948. *The larvae of insects*, part 1. Columbus, Ohio. 315 pp.
- POWELL, J. A. 1958. Additions to the knowledge of the butterfly fauna of Baja California Norte. *Lep. News* 12(1-2) 26-32.
- REAKIRT, T. 1866. Coloradian butterflies. *Proc. Ent. Soc. Philadelphia* 6: 122-151.
- ROBER, J. 1909. in: Seitz, *Macrolepidoptera of the world*, vol. 5. H. Laupp Jr., Tübingen, Germany. 1139 pp.
- SETTE, O. E. 1958. in: Hogue, Minutes of the fifth annual Pacific slope section meetings of the Lepidopterist's Society. *Lep. News* 12(5-6): 209-212.
- SHULL, G. A. 1907. Life history and habits of *Anthocharis* (*Synchlœ*) *olympia* Edw. *Ent. News* 18(3): 73.
- SKINNER, H. 1898. *A synonymic catalogue of the North American Rhopalocera*. Amer. Ent. Soc., Philadelphia. 99 pp.
- . 1902. Lepidoptera of Beulah, New Mexico. *Trans. Amer. Ent. Soc.* 29: 36-38.
- . 1903. in: Smith, *Check list of the Lepidoptera of boreal America*. Amer. Ent. Soc., Philadelphia. 136 pp.



- SMITH, J. B. 1891. *List of the Lepidoptera of boreal America*. Amer. Ent. Soc., Philadelphia. 124 pp.
- SPULER, A. 1908. *Die schmetterlinge Europas*. Stuttgart, Germany. Band 1, 385 pp.
- STORER, T. I. & R. L. USINGER. 1963. *Sierra Nevada natural history, an illustrated handbook*. Univ. California Press, Berkeley & Los Angeles. 374. pp.
- STRAND, E. 1914. Nordamerikanische insbesondere Californische Lepidoptera. *Archiv. F. Naturgesch.* 29(A 11): 151-163.
- . 1927. Liste de Rhopaloceres et Grypoceres exotiques decrits dans mes travaux jus qu'en 1926. *Bull. Soc. Zool. France* 51: 397-418.
- STRECKER, H. 1878. *Complete synonymical catalogue of Macrolepidoptera with a full bibliography*. B. F. Owen, Reading, Pennsylvania. 283 pp.
- TALBOT, G. 1932. *Lepidopterorum catalogus*, E. Strand, ed. W. Junk, Berlin's- Gravenhage, Netherlands. pars 53, Pieridae 1, 698 pp.
- VERITY, ROGER. 1908. *Rhopalocera palaeartica*. Verity, Florence, Italy. 72 pls., 2 maps.
- WARREN, B. C. S. 1961. The androconial scales and their bearing on the question of speciation in the genus *Pieris* (Lepidoptera). *Ent. Tidskrift* 82(3-4): 121-148.
- WEIDEMEYER, J. W. 1863. Catalogue of North American butterflies. *Proc. Ent. Soc. Philadelphia* 2: 143-154.
- WRIGHT, W. G. 1906. *The butterflies of the west coast*. Wright, San Bernardino, California. 257 pp.